Advances in Colloid and Interface Science, 44 (1993) 1–134
Elsevier Science Publishers B.V., Amsterdam

00146 A

NON-EQUILIBRIUM ELECTRIC SURFACE PHENOMENA

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ABSTRACT

Non-equilibrium aspects of traditional electrokinetic phenomena (electrophoresis, electroosmosis, streaming potential, sedimentation potential), electrostatic interaction of particles and new electrokinetic phenomena are considered. The significance of non-equilibrium electric surface phenomena for many major areas of modern colloid science (characterization of colloids, membrane science, transport phenomena and separation, particle interaction and coagulation) is established.

The study of non-equilibrium electric surface phenomena is connected with the validation of the standard electrokinetic model (SEM), the development of a non-standard model and the development of an extensive programme of disperse system characterization based on integrated electrokinetic investigations. Experimental and theoretical studies of systems with a smooth, non-porous impermeable surface (mica in Anderson's experiments, and quartz microcapillaries with a molecule-smooth surface in Churaev's experiments) have shown that usually there are no significant difficulties in interpreting electrokinetic investigations despite the possible anomaly in the water structure near the surface and the possibility of maximum shear stress (yield stress), i.e. the anomalous viscosity and decreased dissolving power with respect to ions. However, systems which do not satisfy the conditions of the SEM are widely distributed, owing to the porosity, roughness or permeability of the boundary layer of the surface of the solid body which simultaneously belongs to the solid and liquid phases. In this layer, enclosed between the outer Helmholtz plane and the slipping plane, the motion of the liquid strongly slows down and the tangential flow of ions is characterized purely by the mobility which is close to the normal. Thus, a general property of a non-standard electrokinetic model is the presence of an anomalous (additional) surface conductivity in excess of the surface conductivity determined according to Bikerman's equation based on the ζ-potential alone.

Confidence in modelling the electrokinetic phenomena has grown with the development of methods for modifying the surface such that its properties approach those of the SEM (Bijsterbosch and co-workers; Saville and co-workers).

Extension of the particle characterization concept requires the measurement of both the mobile charge and the electrokinetic charge and from this an estimate of the thickness of the additional conductivity zone can be made. With the additional measurement of a titratable charge, it is possible to estimate the ion distribution between the dense and diffuse parts of the double layer (DL) and to estimate the decreased mobility of ions in the Stern layer or in the immobilized part of the DL.

Quantitative laws governing the interaction of particles and corresponding to the non-standard model substantially differ from the traditional laws described by the DVLO